III.—*On the Vascular and Nervous Apparatus of the Larvæ of the Marine Crustacea.* By M. Z. Gerbe*.

Vascular Apparatus.—The larvæ of the Crustacea, whatever form they may present, are at first completely destitute of branchiæ; or if they possess them, these organs are quite rudimentary, and do not yet fulfil any function. Respiration, in this state, is performed by the whole of the general envelope. Even in the Lobsters, which are hatched with tolerably large branchiæ, the primitive respiration is absolutely tegumentary; for these appendages are impermeable to the blood until the third moult; and when they begin to perform their functions, the number of blood-globules which they admit is excessively small relatively to the mass of those which flow to the heart without traversing them. From this modification of the respiratory act there results a circulation of the greatest simplicity—the blood which the arteries have distributed in all parts of the body returns directly to the heart without passing through any special apparatus.

The heart, of all the organs exhibited by the Crustacea at their birth, is that of which the general form undergoes the least amount of subsequent change. In the larvæ it differs very little from what it is in the adult Crustacea; and it invariably occupies in the larvæ its definitive position, under the superior wall of the cephalothorax and above the pyloric portion of the intestine. In the *Zoëæ* (larvæ of Brachyurous Decapods) it is found immediately at the base of the temporary spine which rises from the middle of the thorax.

With the exception of the larva of the *Nymphon* of our coasts†, in which I have never yet succeeded in seeing the heart distinctly, all the Crustacea of which I have been able to study the metamorphoses‡ have the central organ of the circulation composed, at all ages, of two very distinct parts—one enveloped, the other enveloping, and bound together only by a few muscular bands, the action of which is manifested during diastole.

The enveloped portion evidently corresponds with the arterial heart of the higher animals. It consists of a sort of contractile

* Translated by W. S. Dallas, F.L.S., from the 'Comptes Rendus,' April 23, 1866, pp. 932–937.

† The larva of this *Nymphon* is exceedingly curious, both in its external form and in its internal organization, and it differs from the adults as much as the Phyllosomes from the *Palinuri*, or the *Zoëæ* from the various Crabs to which they belong. The body is not at all articulated; and the true legs, which are only two in number, have only two joints and a terminal claw. I propose, however, to make them the subject of a special notice.

‡ See 'Comptes Rendus,' 26th December, 1864.

sac, varying in form according to the species, with internal muscular columns and delicate transparent walls, formed of longitudinal and annular muscular fibres intercrossed in various directions; it presents on each side a single semilunar fissure, to which a valve of the same form is adapted internally. From this contractile sac issue all the arteries which perform the distribution of the blood.

The second sac, which is much larger and has its walls thinner and less muscular, completely envelopes the arterial heart, and communicates by two or three oblong apertures with the same number of large venous lacunæ, which convey the blood to the heart. This enveloping portion of the central circulatory organ has been assimilated to the pericardium of the red-blooded animals. In this assimilation there is an appearance of truth, if we consider only the form; but it is far from being exact if we take into account the function, which is very different in importance from the form. The pericardium in the Vertebrata is an organ closed everywhere, without any communication either with the cavities of the heart or with the vessels which run to it; here, on the contrary, the sac which has been assimilated to the pericardium directly receives all the blood into its cavity and transfers it to the ventricle. It is intermediate between the venous lacunæ and the arterial heart, and fulfils exactly the part which, under another form, the auricle, in fishes for example, performs with relation to the *venæ cavæ* and the ventricle. By its functions, therefore, this second cavity would be the analogue of the auricular portion of the heart in Vertebrata.

Five arterial branches issue from the anterior extremity or half of the central contractile sac; only one springs from its posterior extremity. Of the five anterior arteries, one (the ophthalmic artery) follows the median line, passes directly to the brain, and is distributed in the ocular peduncles. In those species in which the rostrum in the young state acquires the form of a long spine, the ophthalmic artery is produced to the extremity of this appendage, after having furnished a branch to each eye. This arterial branch, which is one of the largest, is furnished at its issue from the heart with a double valve, or rather with two opposite flaps, separated at the base, in contact at the apex, which alternately open and close to let pass the globules of the blood and prevent their flowing back into the heart. The action of these flaps, which is completely independent of the contractions of the central organ, is sometimes slow, sometimes rapid; frequently it is even suddenly and momentarily suspended. Two other branches, one on each side, originating a little behind the preceding, also run forward,

following an oblique line, which removes them from the median or ophthalmic artery, emit, in passing, a branch to the rudimentary cæca which represent the liver, and distribute themselves at the base of the outer antennæ. Lastly, the two remaining arteries, at their issue from the arterial heart, are immediately reflexed downwards and lost beneath the liver and upon the sides of the stomach. These four arteries have their base furnished with a simple valve.

The artery which springs from the posterior extremity is generally as voluminous as the anterior median artery. In the Phyllosomes it follows the dorsal line of the intestine for some distance, and then, on arriving at the level of the nervous ganglia of the third pair of true feet, it bends, passes on the left side of the intestinal tube, and divides into two trunks. One of these, which is very large, traverses the ganglionic chain, ascends as far as the mouth, and gives off to the right and left a branch to each of the ambulatory limbs and buccal appendages: it represents the sternal artery. The other, which is very slender, descends to the last abdominal segments, following the course of the intestine, and emits, in its course, a branch to the rudimentary buds which represent the fourth and fifth pairs of true legs.

In the Zoëa-form larvæ, in those of the *Porcellanæ*, Crangons, Lobsters, &c., the posterior artery, instead of dividing only after passing a certain distance, bifurcates at its issue from the heart. One of its branches runs directly down to form the sternal artery, after having traversed the thoracic ganglionic mass at the same point as in the Phyllosomes; the other branch follows the intestine to its extremity, remaining of a considerable size throughout. This branch, which answers to the superior abdominal aorta of the adult Crustacea, presents, in the young Lobsters, a very remarkable peculiarity: on its course, at a distance from the heart and a little above the constriction which separates the intestine into the duodenum and rectum, it has a sort of sphincter or circular valve, which contracts absolutely in the same manner as the pupil of the eye of the cat. Its contractions, which occur at indeterminate periods, progressively and slowly, have the effect of obliterating, entirely or partially, the calibre of the artery, so as to suspend, for some seconds, the circulation in the postabdomen, or to moderate the flow of blood towards that region. This fact is so exceptional that I cannot but call the attention of physiologists to it.

All the arteries, whatever be their size, have their extremities bevelled, and terminate suddenly in a venous lacuna by an oval opening, usually a little dilated into a trumpet-shape.

The venous circulation in the larvæ, as in the perfect animals, is rather lacunar than vascular. The blood which the arteries have distributed to all parts of the body, returns indeed by constant and determinate courses; but these courses consist of a succession of cavities which the organs leave between them, cavities in which it is difficult to ascertain the existence of proper walls or of regular forms. Thus this mode of circulation baffles description. All that can be said in a general way is, that three principal perfectly limited currents, two anterior and lateral and one posterior and median, open into the heart. The two former, in the Phyllosomes, are caused by the fluids which circulate in the cephalic buckler alone; the third is formed by those which arrive from the true feet, the thorax, and the abdomen. In the larvæ of the other Macrurous Decapods and in those of Brachyura, on the contrary, the fluids distributed to the head and thorax combine to form the lateral currents, whilst the posterior current is produced solely by the blood returning from the abdomen.

The elements of the blood in the first age of the Crustacea consist of a perfectly colourless liquid, and small, isolated, diaphanous corpuscles, some oblong or square, others angular or virguliform, with the outlines very distinct, but always very irregular, even when these kinds of globules affect a more or less rounded form.

Nervous Apparatus.—The nervous system of the larvæ of the Crustacea is composed, like that of the perfect individuals, of a double series of ganglia or medullary masses, in which the nerves of all parts of the body terminate. United to each other by longitudinal cords, these ganglia, which are the more voluminous in proportion as the organs of the life of relation to which they correspond are more developed, form a continuous system upon the median line, extending from the base of the ocular peduncles to the last joint of the abdomen. Nevertheless, taking into consideration the regions occupied by it, the central nervous apparatus may be divided into a cephalic, thoracic, and abdominal portion.

The cephalic portion, or brain properly so called, is composed, both in the Phyllosomes and in the *Zoëæ* and other larvæ of Macrurous and Brachyurous Decapods, of a single ganglionic mass, situated between the bases of the rudimentary antennæ and symmetrically divided into three uncqual pairs of lobes, each of which furnishes a sensorial nerve. From the two anterior lobes spring the optic nerves, which pass directly into the ocular peduncles; from the two middle ones arise the inner antennary nerves, and from the two posterior the nerves which are distributed in the outer antennæ and to the auditory organ

situated at their base. Each of these lobes likewise furnishes a pair of nerves running to the muscles and the integuments.

Two cords issuing from the posterior lobe of the brain and united by an ante-œsophageal commissure, place this organ in communication with the thoracic portion of the central nervous system. These two cords, which are exceedingly short in the larvæ of the Prawns, *Porcellanæ*, *Maiæ*, *Portuni*, &c., and rather more extended and thickened in the Lobsters, are excessively long and slender in the Phyllosomes, in which they also present a second commissure behind the brain.

But it is especially in the arrangement of the ganglia of the thorax that the larvæ of the *Palinuri* are distinguished from those of other Decapods that I have been able to observe. In the latter, the thoracic nervous system, represented by the five pairs of ganglia related to the buccal appendages, and by the five pairs corresponding with the ambulatory feet, forms a single oblong mass, pierced at the level of the third and fourth pairs of true feet for the passage of the sternal artery—a mass in which the ganglia are so intimately connected that sometimes, as for example in the *Porcellanæ*, scarcely perceptible furrows mark their separation. Each of these ganglia furnishes two pairs of nerves: one issues directly from the central medullary nucleus, the other appeared to me to be intimately connected with the nervous portion which forms the commissures. Their origin would therefore be different.

In the Phyllosomes the thoracic nervous system certainly forms a double chain as in the other species, but the ganglia, instead of being grouped in such a manner as to form a body, are, on the contrary, very distant from each other, their only communications being formed by rather long longitudinal and transverse commissures. Moreover the volume of these ganglia is excessively unequal, being in relation to the development of those organs to which each of them corresponds. The masticatory appendages, the first pair of footjaws, and the true feet of the fourth and fifth pairs being rudimentary or incomplete in the Phyllosomes, the ganglia devoted to these parts likewise present themselves in a rudimentary state.

The concordance which I have just indicated is still more manifest in the portion of the nervous apparatus which belongs to the abdominal region. This region, where everything in the Phyllosomes is in the condition of a mere sketch (the segments of which it is composed, as well as the false legs of which the successive moults cause the appearance), instead of six pairs of ganglia which may be detected in it in individuals furnished with their abdominal appendages, presents nothing but the prolongations of the two nervous cords or longitudinal

commissures, upon which very slight swellings, representing the future ganglia, may barely be perceived.

In the larvæ of the Lobster, on the contrary, and in those of the *Zoëa*-form in which the abdomen is well developed, we see the double ganglionic chain from the very first, formed, as it will be subsequently, of six pairs of ganglia, already of considerable size, and bound together by the longitudinal commissure. Here, as in the thoracic portion of the central system, two pairs of nerves issue from each of the ganglia and from the cords by which they are connected.

IV.—*On the* Menispermaceæ.

By John Miers, F.R.S., F.L.S. &c.

[Continued from vol. xvii. p. 270.]

29. Stephania.

This genus, proposed by Loureiro in 1793 for two plants of Chinese origin, was for a long time wholly neglected; at length it was acknowledged by botanists, and so far extended by some as to embrace Blume's genus *Clypea*; others, on the contrary, under vague notions of its real characters, gave the preference to *Clypea*, and included in it all the species of *Stephania*. The authors of the 'Flora Indica' and of the 'Genera Plantarum' have united the two genera, on the authority of Prof. A. Gray, who placed little dependence on the constancy of their relative distinctions as I had defined them: his doubts arose from the examination of a plant considered by him to be identical with *Cocculus Forsteri*, DC., which had been referred to *Stephania*; it appeared to him that its floral parts were sometimes 3-merous, at other times 4-merous, in the same specimen—an inference upon which I offered some remarks in speaking of *Clypea* (vol. xvii. p. 268). In all the instances examined by me, which are extremely numerous, I have found, without exception, that the floral parts in the two genera are constantly different in number. *Stephania* in its ♂ flower has six sepals in two series, three smaller petals, and a 6-celled anther; while *Clypea*, as I have shown, has eight sepals in two series, four petals, and an 8-celled anther. In *Stephania* the ♀ flower has three sepals, three petals, and a putamen with a remarkable perforation in the middle of its disciform condyle; while *Clypea* has four sepals, two petals, and a putamen with an imperforated condyle, as in *Ileocarpus* and *Cissampelos*. Many good characters also separate this genus from *Homocnemia* and *Ileocarpus*: although the latter has a similar number of sepals and petals, the imperforation of its condyle renders it distinct; the former has four sepals and